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-	1071	(405/36).CCLS.	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/24 11:21
-	231	leach near4 field	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/23 16:45
-	441	leach$4 near4 field	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/23 16:45
-	458682	dewater or drain	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/24 11:23
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-	85	(leach$4 near4 field) with (dewater$4 or drain$4)	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/23 16:47
-	73	((leach$4 near4 field) with (dewater$4 or drain$4)) and (conduit or pipe or piping or tube or tubing)	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/23 16:48
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-	29	(((leach$4 near4 field) with (dewater$4 or drain$4)) and (conduit or pipe or piping or tube or tubing)) and (biological$4 or biochemical$4 or chemical$4)	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/23 16:50
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-	2713	(septic or leach$4) near2 (field or system)	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/24 11:22

-	458741	dewater or drain	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/24 11:23
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-	235	((((septic or leach$4) near2 (field or system)) with (dewater$4 or drain$4)) and (conduit or pipe or piping or tube or tubing)) and (inject$4 or appl$4 or pressur$6)	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/24 15:32
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-	10	(((drain$4 or leach$4) adj (field)) and (conduit or pipe or piping or tube or tubing)) same (inject$4 or pressur$6) same (aerat$4 or passage$3 or crack$3 or crevice$3) same (soil or ground or field) and (septic or sewage)	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/24 17:36
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-	53	(david near3 potts).in.	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/24 17:38
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-	4	TERRALIFT.AS.	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/25 19:24
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-	16	Suchecki.in.	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/25 19:29

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-	2	("5032042").PN.	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/25 19:30
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-	0	drain adj field adj rejuvenation	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/25 19:34
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-	2	("5383974").PN.	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/25 19:43
-	8	("2528403" | "3202285" | "3658589" | "4201597" | "4525277" | "4824563" | "4925564" | "5228998").PN.	USPAT	2003/11/25 19:44
-	0	5383974.URPN.	USPAT	2003/11/25 19:45

US005810514A

United States Patent [19]

Suchecki, Jr.

[11] Patent Number: 5,810,514

[45] Date of Patent: Sep. 22, 1998

[54] **METHOD FOR INTRODUCING MATERIALS INTO A MEDIUM**

[75] Inventor: **Ronald J. Suchecki, Jr.**, Waco, Tex.

[73] Assignee: **Terralift International, Ltd.**, Waco, Tex.

[21] Appl. No.: **832,140**

[22] Filed: **Apr. 8, 1997**

Related U.S. Application Data

[63] Continuation of Ser. No. 537,991, Oct. 2, 1995, abandoned.

[51] **Int. Cl.**[6] **A62D 3/00**; B09C 1/08; B09C 1/10

[52] **U.S. Cl.** **405/128**; 166/246; 166/280; 210/747; 435/262.5

[58] **Field of Search** 166/246, 249, 166/271, 280, 308; 111/118, 129; 210/747; 405/128, 269; 435/262.5

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Attorney, Agent, or Firm—William A. Bonk, III

[57] **ABSTRACT**

A method for introducing materials into a medium including creating passages in the medium with a blast of a pure preselected compressed gas that encourages activity of a preselected entity within or introduced into the medium and maintaining the passages with preselected materials for maintaining the passages.

8 Claims, No Drawings

METHOD FOR INTRODUCING MATERIALS INTO A MEDIUM

This application is a continuation of application Ser. No. 08/537,991 filed on Oct. 2, 1995, now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to agriculture. More specifically, the present invention relates to methods and apparatuses for loosening and remediating contaminated soil.

2. Description of the Prior Art

Environmental pollution and contamination is one of the greatest threats facing modern society. Environmental contamination invades the water supply for both human and the other populations on which humans rely. In dump sites and other storage facilities toxic pollutants emit noxious chemicals, liquids, gases, and other substances which can injure or even cause death to humans and the other populations. There are numerous sources of environmental pollution including the disturbance of naturally occurring deposits of toxic materials as well as a long list of contaminants introduced into the environment by human neglect, waste, dumping, or mismanagement. Some of these contaminants can be identified as motor oil and other petroleum based products, including gasoline, kerosene, diesel, hydraulic fluid, synthetic oils, other lubricating materials, and BTEX components; paints, paint thinners, and other volatile organic compounds; corrosive and deadly materials, such as chromium, arsenic, radio-active materials, and all other RCRA listed chemicals, compounds, and materials.

Environmental contaminants exist in either soil, water, some other medium, or a combined medium. A soil is best defined as actual dirt, clay, and other naturally occurring earthen substances. Soil is usually found in, at, or near storage containers for contaminants, both above and below the surface, industrial manufacturing and development locations, and other locations where contaminants are used, made, stored, or otherwise exposed to the environment. A medium is any manmade solid, or semi-solid substance where environmental contaminants can exist. A medium includes, for example, solid-waste disposal sites, such as dumps, where human garbage and trash is buried, compressed, or stored, man-made storage and contaminant substances, such as foam, sludge, gels, and other substances, and other more solid, permanent containment fields, such as concrete and cement.

In an attempt to prevent and remedy the detrimental effects of these environmental contaminants, two primary strategies have been implemented: ex-situ remediation and in-situ remediation. Ex-situ remediation consists of physically extracting the soil or other medium from the surrounding earth or under-ground location, treating the extracted soil or medium, and then replacing it into the surrounding earth. In-situ remediation attempts to treat and neutralize the contaminants that are latent within the soil or medium without physically extracting the contaminated soil or medium. The general practice of both ex-situ and in-situ remediation only attempts to treat the contaminants found in soils and does not attempt to treat the contaminants found in the other media. As a result, the following analysis of the prior art describes the most common ex-situ and in-situ remediation techniques for treating contaminated soils.

Ex-situ remediation by definition involves the removal of the contaminated soil from its native environment, treatment of the removed soil by either a physical or chemical means, and then a return of the soil to its original locus. After removing the soil, the common practice is to place or store the unearthed, contaminated soil in either a sealed or open air volatilization area for treatment. After treatment or simply removal from the contaminant's original location, the treated soil is either returned to its source or it is stored or buried in a hazardous waste landfill or contaminant area, where future liability exists indefinitely. If the contaminated soil is removed and not returned to its original removal site, then other soil must be found to fill the void that is left behind. Currently, ex-situ remediation utilizes several methodologies: Thermal Desorption, Thermal Destruction, Incineration, Stabilization, Solidification, Soil Washing, Chemical Treatment, Biological treatment, Land Farming, and other viable methods.

Because of the high costs of transportation, the potential impossibility of removal, and the damage inflicted on the land from which the soil is removed, as well as other negative factors, the in-situ theory and methodology has usurped the ex-situ theory and method of remediating contaminated areas.

In some situations, in-situ remediation has proved to be a more cost-effective and reliable method for remediating environmentally contaminated solid than any of the ex-situ methods, if and when it can be achieved. Generally, the goal of in-situ remediation is to neutralize or remedy the deleterious human and environmental effects of contaminated soils. The most prominent and advanced methods of in-situ remediation include Vitrification, Stabilization, Solidification, Soil Flushing, Air-Sparging, Free Product Recovery, Chemical Treatment, Electroosmosis, Vacuum Vapor Extraction, Bioremediation, Bio Venting, Hydraulic Fracturing, and Pressurized Pneumatic Fracturing.

Vitrification is a process used for stabilizing soils or sludge contaminated with radioactive, metallic, or certain organic wastes, whereby they are made "glass like." Vitrification can be performed in-situ or in special refractory liners. To perform in-situ vitrification, a mixture of ground glass frit and graphite flakes are inserted below the surface of the solid between 4 electrical probes. Electrical voltage is then applied to the electrodes which heats the surrounding soil and mixture, causing the mixture and the soil to melt. Once molten, the soil begins to conduct electrical current and the graphite is consumed by oxidation. The molten soil grows outward and downward until the desired vitrification depth is obtained. However, this electrical vitrification has two primary drawbacks: first, vitrification only seals the contaminant below the surface in a permanent form which cannot be removed or recovered and second, vitrification can only be performed to a contaminant twenty (20) feet or less beneath the surface.

Stabilization, as a broad categorization, includes different processes which attempt to make the environmental contaminants less soluble, mobile, or toxic and thus reduce the potential human and environmental risks caused by the contaminants. Stabilization can be achieved by changing pH, moisture contents, or chemical matrix. Although stabilization can neutralize some contaminants, the chemical nature of the waste is not necessarily changed.

Solidification refers to processes that encapsulate the contaminant into a monolithic solid of high-structural integrity. Solidification includes two primary classifications: microencapsulation, where small contaminated areas are solidified, and macro-encapsulation, where large areas of contamination are solidified. Solidification does not necessarily involve a chemical interaction between the contaminant and the solidifying reagents, but may mechanically bind the waste into the monolith. Contaminant migration is restricted by vastly decreasing the surface area exposed to a leaching area or by isolating the waste within an impervious capsule.

Soil Flushing attempts to enhance the mobilization or ability or the contaminants to move within a soil, so that the

contaminant can be recovered or treated. Soil flushing uses water, enhanced water, mixtures (surfactants), or gaseous mixtures to accelerate one or more of the same geochemical dissolution reactions that alter contaminant concentrations in ground water systems. Soil flushing has two primary applications: one, the recovery of mobile degradation products which are formed after the soil has been treated with chemical oxidizing agents and two, oil recovery operations. Soil flushing is most effective in sandy soils and its effectiveness is dependent on the matrix as well as the organic, inorganic and contaminant composition of the soil or medium in which it is used.

Air sparging is accomplished by injecting air under pressure below the soil surface. Air sparging strives to volatize and biodegrade the contaminants located within the air-flow pathways latent within the soil. Also, air-sparging potentially allows the dissolved phase contaminants that contact the air-flow field to volatize or biodegrade. Air Sparging extends the utility of "soil vapor extraction." The primary draw-back to air-sparging is that once air is injected into the saturated zone, its flow is primarily governed by the applied pressure, buoyant forces, vertical and horizontal permeability distributions in the saturated zone, and the capillary properties of the soils. In short, air-sparging does not create new "air-flow zones" into which the contaminants can flow, volatilize, and biodegrade, but instead relies on the naturally occurring air-flow passageways.

The Basic Free Product Recovery system is a very simple means of recovering large quantities of free product, which is any type of spilled, leaked, or naturally occurring pools of potentially environmentally threatening contaminants in liquid form. In the usual basic free product recovery method a well is drilled into the ground which provides a low pressure space into which any existing "free product" can escape. This is an effective method for removing large quantities of liquids; however it has little or no effect on products which are not "free." One major draw-back to this process is that products which are not free but are bound in the clays, silts, or other components of the soil matrix, sediments, sludge, or water do not naturally "flow" into these low pressure areas. Moreover, this process in almost all cases must be coupled with other methods of remediation to excise the contaminants that are not free, and thus bring the contamination to acceptable levels.

Chemical treatment systems refer to the use of reagents to destroy or chemically modify target contaminants. These chemical processes are used to treat contaminated soils, ground water, surface water and concentrated contaminants. The use of the chemical treatment method is circumscribed by the innate limitation of chemicals to flow through solid, non-porous soils and media, thus limiting the depth of its application and its effectiveness at reaching the contaminant.

Electroosmosis was developed in the 1930's and has been used to dehydrate clays, silts, and fine sands in road beds, dams, and other engineering structures. The electroosmosis process is based on the fact that clay particles are usually negatively charged and thus attract positively charged ions (cations) to form a layer on the surface of water within the pores of the clay. If an electric field is established using electrodes, cations will migrate toward the cathode, bringing the water along with them. Electroosmosis provides uniform water flow through soils and media, including heterogeneous materials. The direction of water flow is easily controlled via the placement and polarity of the electrodes. Electroosmosis is an inadequate means to eradicate solid contaminants or contaminants that are not ionic.

The Basic Vapor Extraction system combines the use of vapor extraction wells with either blower or vacuum pumps. Basic Vapor Extraction drills wells, essential air passage ways, and then applies either a blowing or vacuum device to create a flow of contaminant vapor from zones permeable to vapor flow into the extraction wells. Vapor Extraction enhances the volatilization and removal of contaminants from the subsurface for treatment. The vacuum developed in the extraction well draws air from the above the soil atmosphere through the soil, so as to cause the different contaminants to volatilize and release into the moving air. More complex soil vapor extraction systems incorporate trenches, horizontal wells, forced-air injection wells, passive air inlet wells, ground water recovery systems, impermeable surface seals, multiple vapor extraction wells in single boreholes, and various thermal enhancements. The main limitation to the vapor extraction method is that air only moves into the pre-bored vaporization well holes and only those contaminants exposed to the pre-drilled well holes are able to be remediated.

Bioremediation exploits the ability of certain microorganisms, the heterotrophic bacteria and fungi, the degrade hazardous organic materials to innocuous materials such as carbon dioxide, methane, water, inorganic salts, and biomass. Microorganisms may derive the carbon and energy required for growth through biodegradation of organic contaminants, or, transform more complex, synthetic chemicals through fortuitous co-metabolism. There are two types of Bioremediation which are used: natural and enhanced. Natural Bioremediation depends on indigenous microbes to degrade contaminants using only nutrients and electron acceptors available in the remediation site. However, biodegradation rates will be less than optimal if the microbes' nutritional and physiological requirements are not met. Enhanced Bioremediation technologies increase biodegradation rates by supplying those nutrients, electron acceptors, or other factors that are rate limiting. Yet, even applying the current methods of in-situ remediation, neither correct nutrients to feed the indigenous microbes nor alien microbes can reach all or even most of the contaminants resident within the soil.

The current uses of bioremediation have been enhanced by utilizing the techniques of "bio-venting." Bio-venting is simply the application and combination of well hole boring and vacuum vapor extraction with the bioremediation methods discussed above. Under natural conditions aerobic biodegradation rates are typically limited by oxygen supply rates in the soil subsurface. The rate of oxygen supply to the subsurface is increased during the course of vapor extraction as air is drawn from the atmosphere into the subsurface. Therefore the enhanced supply of oxygen to the subsurface will increase the rate at which the aerobic biodegradation of contaminants can take place. However, the supply of air is still limited to the number of air-flow channels created by the number of well holes bored and the amount of contaminants and microbes exposed to the air flow.

Another means of in-situ remediation is hydraulic fracturing. Hydraulic fracturing is a technique developed in the oil and gas industry for creating openings in the soil subsurface. Hydraulic fracturing is accomplished by applying a high-pressure slurry of water or some liquid into the subsurface to create a lateral, pancake-shaped space in low-permeability zones. Sand in the slurry remains in the fracture, supporting it and keeping it open. Hydraulic fracturing is limited in its application because it can utilize only microbes that can live in the liquid or rely thereon.

One of the latest methods applied to in situ remediation is the pressurized pneumatic fracturing method developed by the New Jersey Institute of Technology (NJIT). The NJIT pressurized pneumatic fracturing method relies on a cylindrical probe inserted in the ground for means of transporting a pressurized gas below the surface of the ground for the purpose of pneumatically fracturing the soil. The process relies on the slow buildup of pressure to fracture the soil.

The desired benefits of the pressurized pneumatic fracturing method is that it should open sub-surface areas into which contaminants could flow and thus volatilize. However, while the pressure and buildup necessary to fracture the soil is being applied, it is a safe scientific inference to believe that the contaminants are actually being pushed into boundaries outside of the original contamination site, the contaminants are being further compacted into the existing soil, and thus frustrating and limiting the recoverability and remediation potential of the contaminant.

SUMMARY OF THE INVENTION

The present invention overcomes the limitations of the prior art by providing a method for fracturing a contaminated soil with a sudden, explosive blast of a preselected pure compressed gas. The preselected pure compressed gas is specially suited to encourage activity of preselected organisms already within or introduced into the medium. The present method also advances over the prior art by employing unique filler materials for maintaining the fissures or passages generated by the fracturing method, thus enhancing the remediation process.

Accordingly, a first object of the present invention is to provide a method for introducing material into a medium.

A second object of the present invention is to provide a method for introducing material into a medium including generating a shock-wave within the medium to molecularly and physically free the contaminants that are trapped in the media.

A third object of the present invention is to provide a method for introducing material into a medium including introduction of a pure compressed gas to enhance activity of preselected organisms within or introduced into the medium.

A fourth object of the present invention is to provide a method for introducing material into a medium including introducing organisms, chemicals, bio-active chemicals and inert material into the medium.

A fifth object of the present invention is to provide a method for introducing material into a medium to bring about certain reactions in the chemicals, aerobic and anaerobic organisms, and inert materials that are existing or have been injected into the media.

A sixth object of the invention is to provide improved elements and arrangements thereof in a method described herein that is dependable, economical and effective in accomplishing its stated and implied purposes.

DETAILED DESCRIPTION OF THE METHOD

The present method includes the step of creating at least one passage in the medium. This passage creation is accomplished, preferably, by injecting a blast of a preselected compressed gas into a medium. This method may be applied to numerous types of media, including soil, man-made structures, solidified contaminant masses, sludges, and other media where contaminants exist.

The sudden blast of compressed gas causes at least one shockwave to emanate through the medium from the point of release. A shockwave is an instantaneous disruption created by the presence of more energy on the wave front than the structure which is contacted by the wave can support. When the sudden burst of gas is released, a wave of energy is sent, both vertically and horizontally, through the medium, which instantaneously moves and disrupts the contaminant and the medium. This shockwave loosens the embedded contaminants and frees the soil, making contaminated areas accessible to gases or remediation agents such as chemicals, bio-active chemicals, organisms, or inert materials. The shockwave caused by the sudden burst of gas creates paths of least resistance within the medium, which serve two purposes: creation of gas-guiding passages for the introduction of materials to treat the contaminants and provision of free space into which contaminants can flow so that they can be treated.

Not only does the present invention emit a shockwave which disrupts the matrix and structure of the medium, the sudden burst of gas also creates a novel matrix of gas-guiding passages. When the sudden blast of air is released into the medium, the gas flows into the areas of least resistance and therefore follows the natural structure of the medium and creates voids through which gases could flow and materials could be introduced. The shape and dimension of the gas-guiding passages depends on two primary components: the location and angle of the release of the sudden burst of gas and the composition of the media. The angle of introduction of the gas will determine the angle and positioning of the matrix of gas-guiding passages, which would affect the types of treatments that could be applied to the particular medium. More importantly, however, is the understanding of the composition of the medium. Depending on the type of soil and its structural composition, the specific matrix created by the sudden burst will vary. Thus, a practitioner skilled in the art could determine the angle of introduction of the sudden burst of gas to determined the pattern and shape of the desired matrix of gas-guiding passages, so as to enhance the possible remediation of existing contaminants.

While some practitioners in the prior art make holes in the soil, none are as effective or as thorough as the gas-guiding passages created by the present invention. Practitioners in the prior art have either drilled vertical or horizontal wells, excavated or tilled the soil, or attempted medium fracture by means of slow pressure build-up. The physically invasive methods such as drilling, digging and tilling the soil actually alter the position and integrity of the soil, exposing certain parts to sun light, partially treating others, and leaving the majority of the soil contaminated and untreated. Contrarily, the gas-guiding passages created by the sudden burst of gas and the concomitant shockwave utilizes the naturally occurring fracture lines in the medium to evenly disrupt and expose the medium. This natural disruption pattern literally tears the medium, loosens the medium structure, and allows a greater amount of materials to reach the contaminants and thus enhance the remediation process.

A benefit gained from the present invention is that the soil structure is maintained without significantly affecting the life of the soil, as is the case with the mechanical means of treating the soil. Moreover the medium is torn according to the pre-defined, naturally occurring breaking lines and is made permeable, thus making the medium more accessible to preselected desirable gasses, such as oxygen.

The present invention is superior to the prior art in that the degree of disruption is controllable. The present invention can be used at differing depths and to differing degrees of fineness. The method according to the invention may be employed for breaking up the medium over wide surfaces in a coarse way as well as for breaking up the medium in a fine narrow mesh manner and is particularly suitable to break up deep-lying compacted zones. This applies to compacted medium of any type and with a moist medium simultaneously brings about a certain flow.

A crucial component of the invention is the employment of a pure, preselected compressed gas to fracture the medium. The specific gas used is determined in light of the entity, or entities, extant in, or simultaneously or subsequently introduced into, the medium. In other words, the gas choice depends on what entities are regarded as useful for the particular purpose to which the method is directed and what gases encourage their activity. For example, some

aerobic organisms, such as bacteria, are well known for their ability to digest petroleum products and break them down into more environmental beneficial components. These kinds of bacteria perform the elemental breakdown of the petroleum product better in the presence of oxygen. Accordingly, applying the present method to a medium contaminated with a petroleum product would call for selecting pure oxygen as the fracturing gas agent. The blast of pure oxygen not only creates the necessary passages for infusing the medium with the remediative gas of choice, but also encourages the activity or digestive processes of the preselected bacteria that may already exist within the medium. The above example including an organism should not be construed as limiting gas selection to encouraging only organic activity. The present method embraces exploitation of useful enzymes and other inorganic matter which may exist or may be introduced into the medium.

The prior art includes many examples wherein air is employed to fracture the medium. It is well known that air does contain oxygen which may satisfy many organisms that fulfill the objectives of the present method. However, air also contains many other components that may harm or discourage the activities of the preselected organic and/or inorganic entities within or introduced into the soil. For example, some aerobic organisms may not be able to tolerate any amount of carbon dioxide introduced into a medium. If a blast of air were used to fracture the medium followed by te introduction of pure oxygen, the particular aerobic organisms of interest already may have perished even in the presence of trace amounts of the carbon dioxide in the air used.

The result of the sudden burst of gas and the concomitant shockwave is a series of gas-guiding passages which can be held open or maintained with maintaining material, such as microorganisms including anaerobic and aerobic bacteria, and various classes of fungi; inorganic materials such as absorbents, chemicals, chemical compounds; organic substances such as enzymes, bio-active sludge, cellulose, compost, humus, pete; and inert materials such as sand, diatomaceous earth, Fullers earth, barite, bentonite, polystyrene beads; or similar materials known to those skilled in the art to maintain fissures or passages. The introduction of these materials into the gas-guiding passages ensures that these spaces will serve as permeable passageways for water, gases, liquids, and other materials.

Once the sudden burst and concomitant shockwave has ruptured the soil and created gas-guiding passages, the practitioner may introduce materials which neutralize, volatilize, or react with the contaminant to make the medium safe to humans and other populations. Although most scenarios would require the practitioner to introduce specialized materials, the gas-guiding passages can be created in a formation, which allows the natural laws of science and physics to remedy the contamination process. The following represents, but should not be construed as limiting, remediating materials that may be introduced into the passages: organisms, which consume or disintegrate the contaminant; nutrients, in the form of air or any other compressed gas, which feed and sustain the organisms in the medium, whether naturally occurring or manually introduced; chemicals, which react and stabilize the contaminant; bio-active chemicals which cause certain biological organisms to respond and destroy or neutralize the contaminant; and inert materials, which would maintain the gas-guiding passages and thus maintain the gas and liquid permeability of the medium. Most importantly the present invention assures that the treatment and thus the contaminant is treated in a homogenous manner.

Although the invention has been described with reference to specific embodiments, this description is not meant to be construed in a limited sense. Various modifications of the disclosed embodiments, as well as alternative embodiments of the invention will become apparent to persons skilled in the art upon reference to the description of the invention. The appended claims are intended to cover all embodiments that fall within the scope of the invention.

I claim:

1. A method for introducing materials into a medium comprising the steps of:

creating at least one passage in the medium through a sudden burst of compressed gas specifically adapted to encourage activity of a preselected entity extant within the medium; and

introducing into the at least one passage a material maintaining the at least one passage;

said material maintaining the at least one passage being selected from the group consisting of anaerobic and aerobic bacteria, fungi, enzymes, bio-active sludge, cellulose, compost, diatomaceous earth, Fullers earth, barite, bentonite, and combinations thereof.

2. A method as recited in claim 1, wherein said step of creating at least one passage in the medium includes introducing into the medium at least one shock wave.

3. A method for introducing materials into a medium consisting essentially of introducing into the medium a blast of a compressed gas specifically adapted to encourage activity of at least one preselected entity extant within the medium.

4. A method for introducing materials into a medium consisting essentially of the steps of:

creating at least one passage in the medium with a sudden blast of a compressed gas specifically adapted to encourage activity of at least one preselected entity extant within the medium; and

introducing into the at least one passage at least one remediating material.

5. A method as recited in claim 1, including the step of introducing into the at least one passage at least one remediating material.

6. A method as recited in claim 1, wherein said compressed gas is oxygen gas.

7. A method as recited in claim 3, wherein said compressed gas is oxygen gas.

8. A method as recited in claim 4, wherein said compressed gas is oxygen gas.

* * * * *

US005200065A

United States Patent [19]

Sinclair et al.

[11] Patent Number: 5,200,065

[45] Date of Patent: Apr. 6, 1993

[54] TERTIARY WASTE TREATMENT AND DISPOSAL SYSTEM

[75] Inventors: John A. Sinclair; Thomas A. Sinclair, both of Lilburn, Ga.

[73] Assignee: Waste Water Systems, Inc., Lilburn, Ga.

[21] Appl. No.: 660,530

[22] Filed: Feb. 25, 1991

[51] Int. Cl.[5] C02F 9/00; E02B 11/00; B01D 29/62

[52] U.S. Cl. 210/104; 210/108; 210/143; 210/195.1; 210/258; 210/532.2; 405/37

[58] Field of Search 210/108, 104, 143, 258, 210/277, 278, 393, 410, 411, 427, 170, 614, 618, 630, 123, 533, 532.2, 535, 798, 805, 167, 196, 195.1, 121; 239/542; 405/37

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Assistant Examiner—Sun Uk Kim
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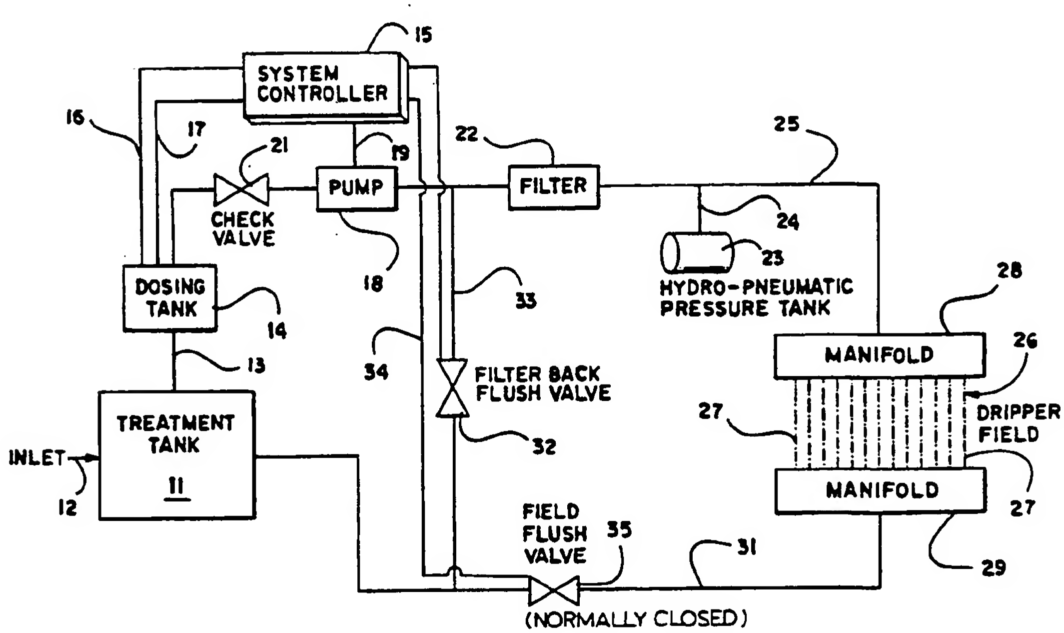
[57] ABSTRACT

A waste water treatment and disposal system for further treating waste water effluent from a primary treatment system in which a system controller controls the operation of the system. A dosing tank accepts effluent from a primary treatment system and is evacuated on demand by a pump which is energized in response to a fluid level switch in the dosing tank. The pump forces the effluent through a filtering system to remove solid waste therefrom, and then forces a portion of the filtered effluent into a hydro-pneumatic pressure tank which, upon call, will backflush the filter to remove the trapped solids therein. The system controller will monitor the system to operate the level of the dosing tank, the operation of the pump and the various valves which control the flow throughout the system. The filtered effluent will ultimately be discharged into a disposal area by any number of well known methods. One such method may be by a dripper field in which the effluent is emitted through multiple drip emitters in a plurality of pipes laid underground. The system also has the capability of backflushing the dripper field to maintain the emitters open and operating.

2 Claims, 3 Drawing Sheets



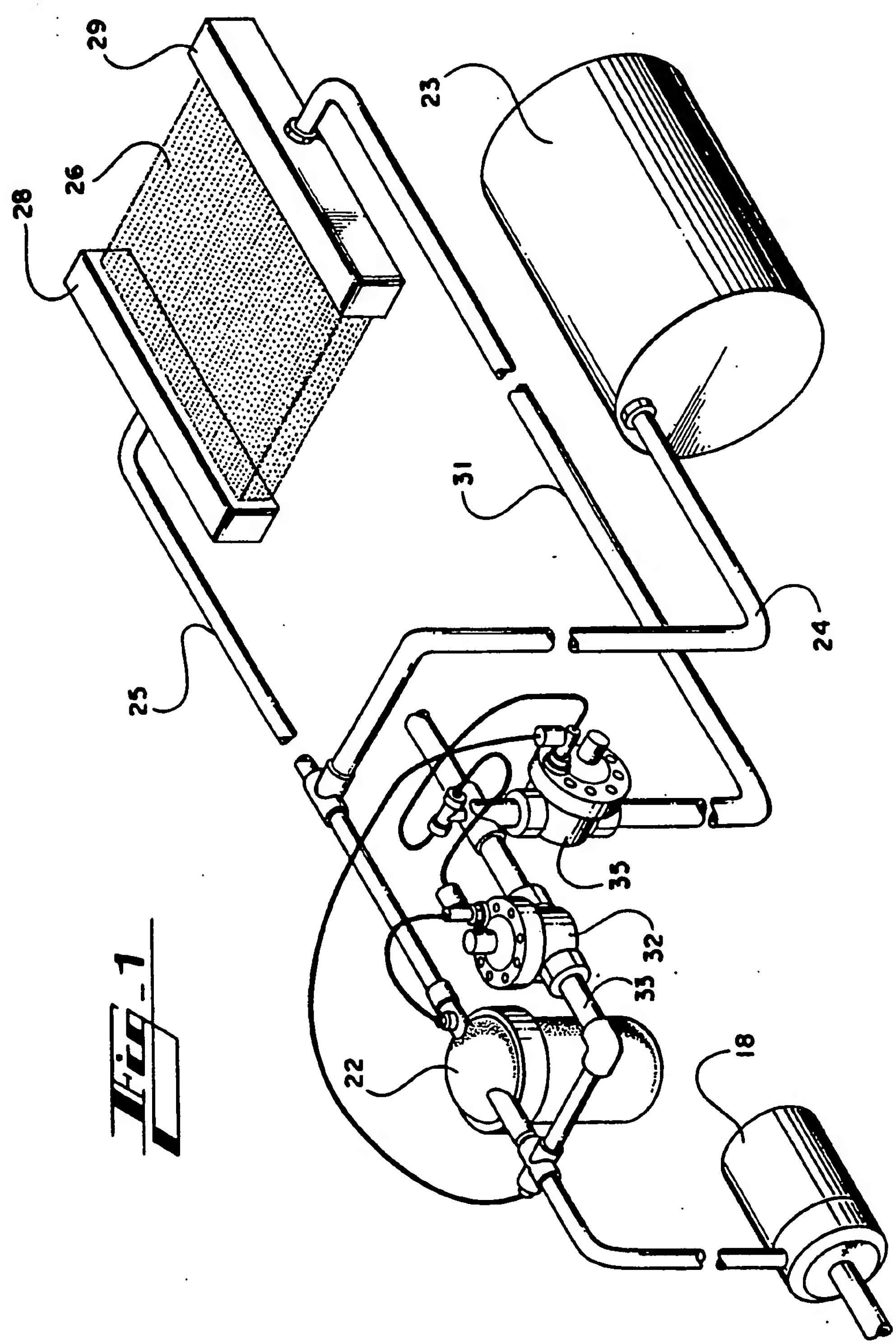
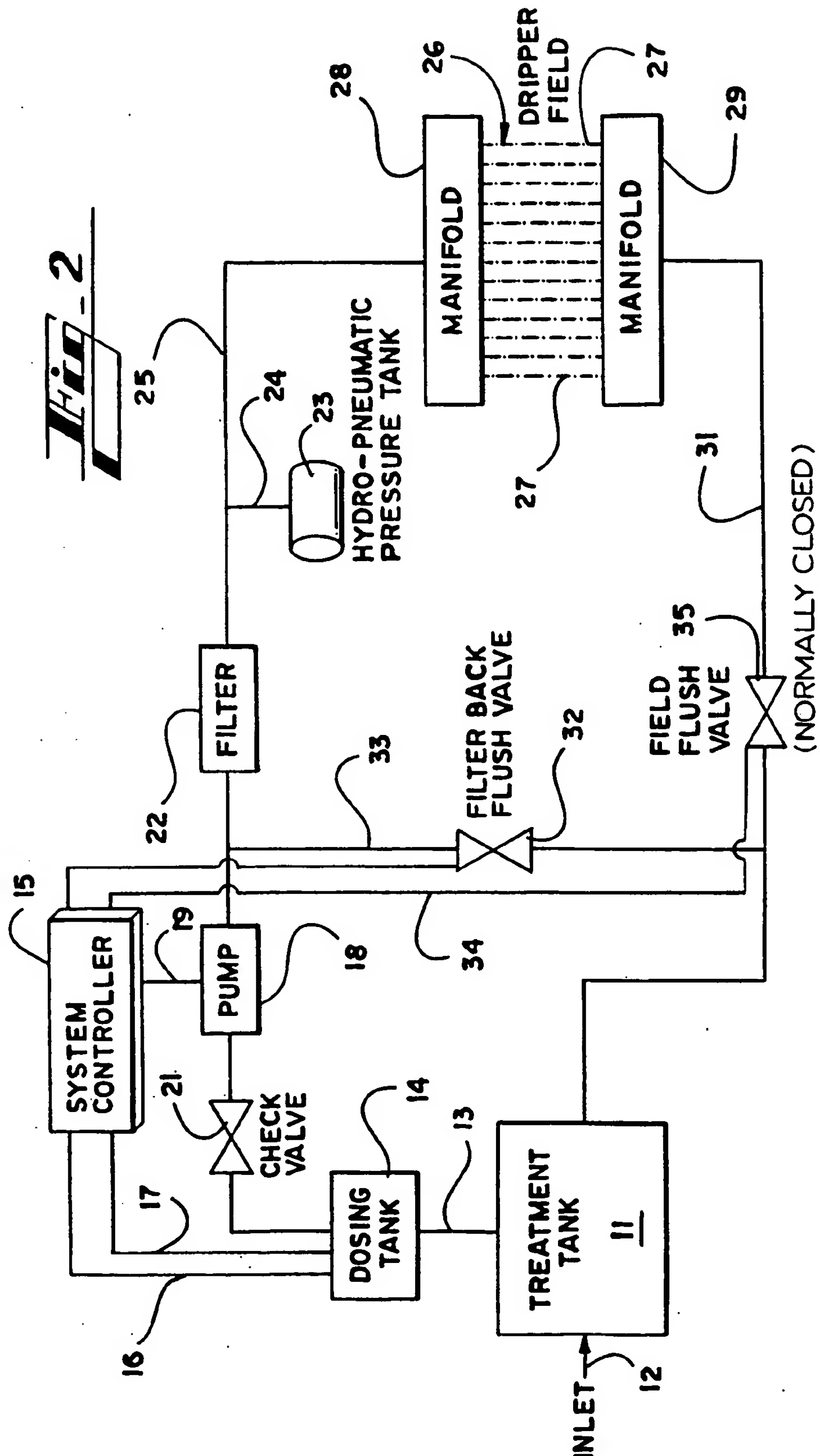


FIG_1

FIG. 2



INLET
12
TREATMENT TANK
11
13
DOSING TANK
14
16
17
CHECK VALVE
21
SYSTEM CONTROLLER
15
PUMP
19
18
34
FILTER
22
33
FILTER BACK FLUSH VALVE
32
FIELD FLUSH VALVE
35
(NORMALLY CLOSED)
31
HYDRO-PNEUMATIC PRESSURE TANK
23
24
25
MANIFOLD
28
MANIFOLD
29
DRIPPER FIELD
26
27
27

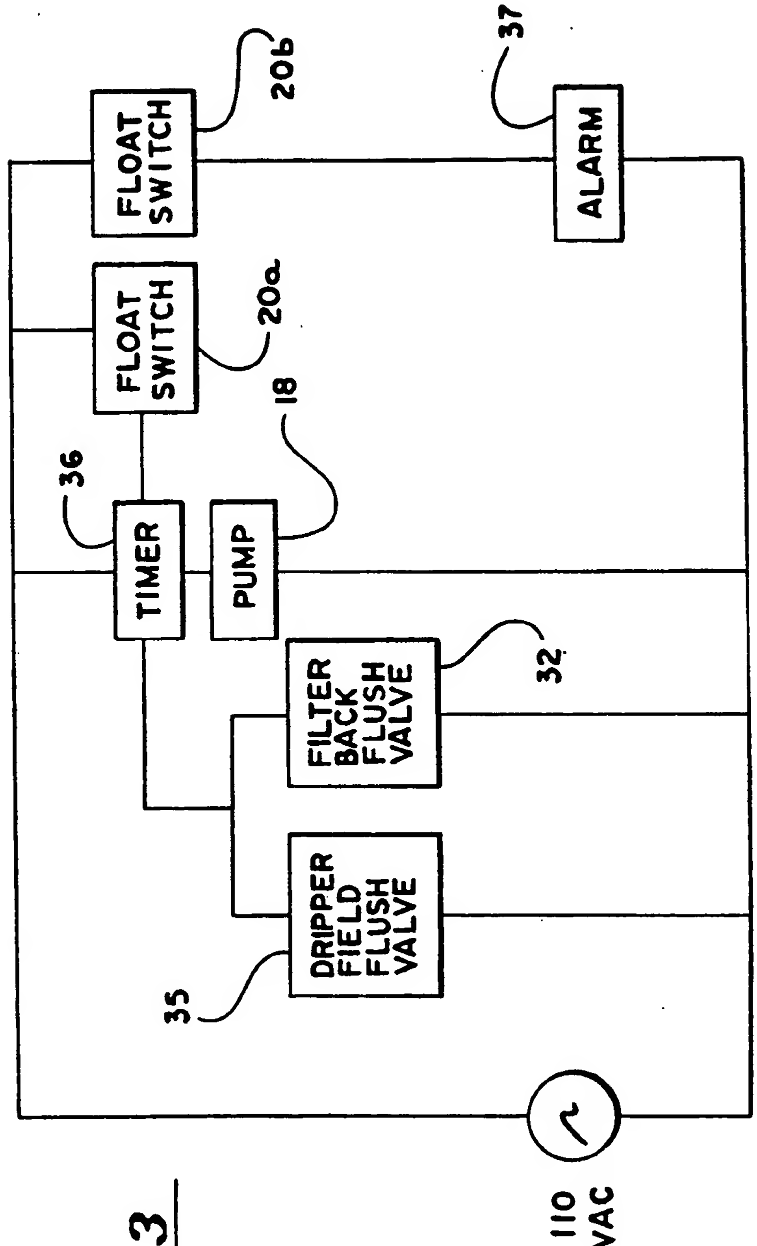

FLOAT SWITCH
20b
ALARM
37
FLOAT SWITCH
20a
18
36
TIMER
PUMP
FILTER BACK FLUSH VALVE
32
DRIPPER FIELD FLUSH VALVE
35
110 VAC

Fig. 3

TERTIARY WASTE TREATMENT AND DISPOSAL SYSTEM

BACKGROUND OF THE INVENTION

I. Field of the Invention

The present invention relates to tertiary waste water treatment systems, and especially those treatment systems which are useful in treating waste water generated by single family dwellings, businesses and small industrial plants.

In the treatment of waste water there is often utilized a type of treatment plant which treats received waste product on an intermittent flow basis from the user of the system. In rural areas, it is normal that a user will utilize a buried sub-soil sewage treatment septic tank which is used to treat primary waste products. Such treatment systems are old and well-known in the art, and the septic tank normally receives the flow to be treated on an intermittent basis and then must treat the flow to meet health standards. Typically the septic tank does nothing more than remove a certain amount of solid waste from the waste water stream, and then transfers the waste water through a series of perforated pipes buried in a gravel receiving field in order that the waste water will flow from the perforated pipes into the gravel field and, subsequently, into the ground.

II. Description of the Prior Art

There have been advances over the well-known septic tank treatment system and these advances, which may or may not be feasible for a particular area, include land spray treatment systems, ground buried systems or point discharge systems in which the waste water is pre-treated.

In any system which further treats the waste water stream after leaving a holding tank, it is important and very desirable that a minimum of solid material remain in the waste water stream, especially if the waste water stream is going to be piped into a land spray system or into a buried drip application system. Both types of systems are easily clogged due to the small clearances of the discharge apparatus required for effective application.

SUMMARY OF THE INVENTION

The basic process of the present invention first starts with raw waste water entering into a septic type treatment tank system which normally functions as a anaerobic solids tank, or any other type of sewage treatment process.

In cases where surface discharge, land application or the use of drain fields are not acceptable, the present invention offers a unique tertiary filtering system followed by subsurface distribution of the waste water effluent. The proposed system is operated via a solid state controller which provides the following functions:

(a) high water alarm
(b) power out alarm
(c) pump start control
(d) time back flush of filter
(e) automatic flushing of distribution system
(f) remote monitor of alarm functions

The system is activated by a sensing device located in a dosing tank. When activated by the level of effluent in the dosing tank it will start the pump which, in turn, will cause a normally opened hydraulically operated valve to close and allow the effluent to pass through a 1", 130 micron disc filter. The filter configuration is modular and can be amplified, or expanded, according to needs.

The filtered effluent is pumped through the system filling a hydro-pneumatic tank. The effluent is simultaneously discharged below the soil surface through a chemical resisting, pressure compensating "drip" poly tubing. The construction of the "drip" tubing is unique in that it provides for an exact amount of effluent to be discharged from each of its emitters along its entire length. Because the effluent is distributed at a relatively low rate, large quantities of effluent may be distributed over long periods of time without saturating the surrounding soil thus eliminating the possibility of runoff or surface water.

The automated backflush system is monitored by the controller and is activated by a timer circuit which is preset usually at five minute intervals, with a duration of 15 seconds. When the predetermined filtering time elapses, the valve which is now closed will open by virtue of the pump stopping, which in turn will cause the filtered effluent from the hydro-pneumatic tank to release at approximately 50 P.S.I. This will allow the pre-filtered effluent to reverse the flow through the filter creating the backflush and then discharge back into the treatment tank for reprocessing.

In amplified systems using multiple filters necessitated by larger flows, the hydro-pneumatic pressure tank may not necessarily be used due to sizing requirements for the pressure tank. It is anticipated that filtered water which has been through the filtering stage in such a situation may be backflushed through a filter to accomplish the cleaning.

The dripper lines will automatically flush every 200 dosing cycles. This function is activated through the controller which will open the field flush valve allowing the flushed effluent to be returned to the treatment tank. The duration of this cycle is three minutes.

In the event of a power outage or a high water condition in the dosing tank, an audio alarm will activate. Simultaneously, in an alternative method, a remote service center will be notified via phone line through a central computer. The maintenance company will respond within a designated time. Even in the event of power failure, the system is designed to provide at least an additional 200 gallons of capacity. If a service center is not provided, the alarm for the power outage or high water condition will notify the user of the potential problem.

When this improved system is used for distributing waste water, there are no visible indications that the installation site is being used for such purposes. This distribution system will permit waste water disposal in land areas that are also used for other purposes such as parks, athletic fields, groves, highway rights-of-way and even greenbelt areas around office buildings, trailer parks, and apartment complexes or residential subdivisions.

For existing or new treatment facilities, namely residential, commercial, industrial or municipal, our tertiary filtering and subsurface distribution system can be a viable alternative to land spray application techniques or direct discharge into streams, rivers or lakes.

In addition, as opposed to a typical gravity fed septic drain system, the pressurized drip emitting system for the effluent may be located in areas in which it is impossible to install septic drain fields. For instance, the drip emitting system when utilized with the present inven-

tion can be installed on extremely slopped areas, whether it be uphill or downhill, and may be utilized in soils which normally would not sustain a typical septic drain field.

Other objects, advantages and capabilities of the invention will become apparent from the following description taken in conjunction with the accompanying drawings, showing only a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of certain operative elements of the present invention;

FIG. 2 is a schematic diagram of the elements of the present invention; and

FIG. 3 is an electrical schematic diagram of the system controller.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings wherein like reference numerals designate corresponding parts throughout the several figures, and referring especially to FIG. 2 showing a schematic of the entire system, the process generally will commence with waste water flowing into the treatment tank 11 at inlet 12. The treatment tank may be of any suitable type, such as a standard septic system tank which acts as an anaerobic holding tank, or it may be an aeration system providing aerobic treatment to the waste water stream, or any other type of treatment system.

From the treatment tank 11 the effluent then traverses through suitable piping 13 to the dosing tank 14, which receives the effluent on demand of the system. The dosing tank, in conjunction with the system controller 15, controls and provides waste water effluent to the entire system. The level of effluent in the dosing tank is sensed by the system controller 15 through a float switch 20*a* within the dosing tank and sensed through electrical control line 16. Should the dosing tank become filled excessively with waste water, a high water alarm is provided to the system controller and a second float switch identified by numeral 20*b*, is enclosed in the dosing tank and monitored by the system controller 15 through electrical sensing line 17 in order to provide an alarm to the user of the system, when the alarm 37 is activated, that there is a potential problem due to high water within the dosing tank, thereby indicating a malfunction within the system. An electrical diagram of the system controller 15 is shown in FIG. 3, wherein the controller is supplied with a suitable source of electrical energy. The source may be 110 VAC, or it may be battery powered depending upon the circumstances and the nature of use of the controller.

As the system controller senses the proper level of water within the dosing tank through float sensing line 16, the controller will turn on the pump 18 through electrical connection 19. At this point, the pump evacuates the dosing tank to a required level thereby drawing waste water from the dosing tank through the one-way check valve 21. The effluent is passed through filter 22 and through flow line 24 thereby filling the hydropneumatic pressure tank 23.

Once the tank 23 is filled and pressurized, the effluent then traverses through flow line 25, to the dripper field 26, which is shown schematically in FIG. 2. For proper distribution through the drip emitting tubes 27, the effluent flows into an upper manifold 28 and thence through the dripper tubes 27, and then out through the individual emitters (not shown) into the ground.

In operation of the present system, and as previously noted, when the waste water level in the dosing tank reaches a pre-determined level the timer 36 of system controller will turn on pump 18 thereby evacuating the dosing tank, forcing the effluent through filter 22 to filter out remaining solids, and pressurizing the hydropneumatic pressure tank 23 and thence forcing the effluent through the emitters in the dripper field 26. Typically the pump will run on a timed cycle as is indicated by the demand and operating characteristics of the system. The typical cycle may be for 5 minutes, at which time the pump would then be cut off by the timing mechanism 36 within the system controller 15. At this point, the pump would cease operation and system controller 15 would open the filter backflush valve 32 allowing the evacuation of the hydropneumatic pressure tank 23 in a backwash mode through filter 22, thereby cleaning any trapped solids from within the filter and thence forcing the backflush water through flow line 33 and ultimately back into the treatment tank 11. After a timed backflush cycle, the system controller will then close the backflush valve 32 and the system is once again readied for accepting effluent from dosing tank 14.

In order for the dripper field 26 to properly operate, and since the emitters from the drip lines 27 have relatively small apertures, there is a possibility that the apertures could become clogged over a period of use. The present invention contemplates a method by which the dripper emitters may be flushed of any trapped solids to maintain the emitters in an open and operating condition. This is accomplished on a timed cycle, while pump 18 is operating and forcing effluent into manifold 28, by the system controller 15 signalling by means of electrical connector 34, field flush valve 35 to open thereby allowing a rapid and substantial movement of effluent through the dripper field lines 27 through flow line 31 and, subsequently, into the treatment tank 11. The rapid flow of effluent through lines 27 of the dripper field 26 and through lines 27, will create substantial turbulence throughout the lines 27 and ultimately will remove impacted solids from the emitters of the dripper lines 27. Typically, the cycle for the field flush valve will be approximately 3 minutes and it has been found that this type of a cycle will adequately maintain the emitters and the dripper field in an operating condition. Once the field flush cycle is completed, the system controller will then close valve 35 and the system will once again begin to operate in the normal intended discharge mode.

At such times as the dripper emitters in the dripper field 26 are flushed upon opening of the field flush valve 35 and the rapid and substantial movement of the effluent through the dripper field lines 27, the effluent is typically collected at a central point for transportation through the field flush valve 35 and into the treatment tank 11. A schematic of this system is shown in FIG. 2, wherein manifold 29 is a collection point for the effluent to be channeled into line 31. Manifold 29, however, is not necessarily a manifold in the sense that manifold 28 is, but manifold 29 is a convenient term to use for a point where all of the dripper field lines 27 meet to tie into line 31. The field flush valve 35 in order to be effective, should be located somewhere between treatment tank 11 and the downstream end of dripper field 26. For convenience in a normal system, valve 35 would be

located after the dripper field lines 27 are merged to the flow line 31. However, it should be noted that field flush valve 35 could be installed in multiple numbers, and each dripper field line 27 could have a field flush valve with that particular line. However, as previously noted, most systems would have just one field flush valve to handle the entire dripper field 26, which valve would be at the downstream end of the dripper field 26.

The tertiary treatment system of the present invention, as has been indicated, is preferably used with a subsurface drip irrigation system installed at an adequate depth below the soil surface. The depth of installation is dependent upon factors such as soil type and land usage. The system would be so installed and set for flow rates and spacing of emitters in the dripper field wherein, under normal conditions, the possibility of ground water and surface contamination is eliminated.

It has been found that in a typical residential environment, a waste water treatment system with a 500 gallon per day treatment capacity will be sufficient. For this system, the maximum flow rate is typically estimated at 180 gallons per hour and this will require a disposal system of approximately 300 emitters with each emitter having a flow rate of 0.6 gallons per hour. Therefore, the spacing of the emitter and the depth of installation will depend upon usage rates, soil conditions, land usage above the dripper field and frost line considerations. It has been found that, for certain soil types, certain emitter spacing and geometry may be as suggested in Table 1.

TABLE 1

Guidelines for Emitter Installation for Treated Water Disposal According to Environmental Conditions (Emitter Flow = 0.6 gallons/hour)

Conductivity of Soil (min./in.)	Emitter on Lateral (inch)	Spacings Between Laterals (inch)	Irrigation Rate (Water Consumption) (inch/hr.)	Number of Emitters at 500 gal./day	Disposal Area (feet)	Emitter Depth (inch)
600	36	36	0.11	870	7830	10-20
300	24	36	0.16	542	3252	8-16
120	24	24	0.24	323	1292	8-16
60	24	24	0.24	323	1292	6-12

The present system is especially useful in an agricultural environment and, if properly operated, the irrigation system has the benefit of reducing the need for artificial fertilization of crop areas. The system can be operated automatically year around, and is flexible enough to be adapted to different loadings, soil conditions and plants. If the load upon the system increases, the dripper field 26 may be increased to accept the increase loading without major renovation of the entire system. Such is not possible with a typical septic system of the prior art. As is evident, the present system is relatively inexpensive and is adapted to a wide range of environments and soil conditions, not normally acceptable with current septic type systems.

Various modifications may be made of the invention without departing from the scope thereof and it is desired, therefore, that only such limitations shall be placed thereon as are imposed by the prior art and which are set forth in the appended claims.

What is claimed is:

1. A waste water treatment system for further treating waste water effluent from a primary treatment system, comprising:

a system controller means to control the operation of the treatment system,

a dosing tank means for accepting the effluent and providing a downstream flow of effluent,

means for pressurizing fluid flow downstream from the dosing tank means and throughout the treatment system,

the dosing tank means having at least one float switch within the dosing tank means connected to the system controller means to activate the means for pressurizing fluid flow downstream from the dosing tank means,

means for filtering waste material from the downstream flow of effluent,

the means for pressurizing fluid flow comprising a pump connected in-line between the dosing tank means and the filtering means,

backflush pressure means for accepting filtered effluent from the filtering means to subsequently backflush the filtering means at intervals of time, wherein the backflush pressure means comprises a hydropneumatic tank to store filtered effluent until the system controller means causes the stored filtered effluent to flow from the hydropneumatic tank back through the filtering means to thereby remove filtered waste from the filtering means,

wherein the filtering means comprises a filter in-line between the pump and the hydropneumatic tank,

a plurality of fluid flow tubes to accept the filtered effluent, the tubes having emitting means and discharge means to effect the discharge of the filtered effluent into a ground environment comprising field flush valve means downstream from the means to discharge the filtered effluent through the emitting means, the system controller means providing a signal at selected intervals to operate the pump and to open the field flush valve means thereby creating a forceful turbulent fluid flow through the fluid flow tubes effecting a cleaning of the emitting means and subsequently causing the filtered effluent to flow into the primary treatment system for reprocessing.

2. A waste water treatment system for further treating waste water effluent from a primary treatment system, comprising:

a system controller means to control the operation of the treatment system,

a dosing tank means for accepting the effluent and providing a downstream flow of effluent,

pump means for pressurizing fluid flow downstream from the dosing tank means and throughout the treatment system,

means for filtering waste material from the downstream flow of effluent,

backflush pressure means for accepting filtered effluent from the means for filtering waste material to

subsequently backflush the means for filtering waste material at intervals of time,

means to effect the discharge of the filtered effluent into a ground environment,

wherein the means to effect the discharge of the filtered effluent comprises a manifold to distribute the filtered effluent to a plurality of fluid flow tubes, the tubes having emitted means to discharge the filtered effluent to the ground environment at controlled rates,

wherein field flush valve means are provided downstream from the means to discharge the filtered effluent, the system controller means providing a signal at selected intervals to operate the pump means and to open the field flush valve means thereby creating a forceful turbulent fluid flow through the fluid flow tubes effecting a cleaning of the emitting means and subsequently causing the filtered effluent to flow into the primary treatment system for reprocessing.

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